

cylindrical pattern of adjacent vanes through which the output gases are discharged to drive the turbine.

FIG. 2 is a cross section view of evaporator section 12 of heat pipe 10 of the turbine nozzle of FIG. 1 at location 2—2. Evaporator section 12 is constructed as three chambers, leading edge chamber 26, middle chamber 28, and tapered trailing edge chamber 30 separated by structural ribs 25 and 27. Leading edge chamber 26 and middle chamber 28 are constructed similarly in that they have powdered metal wicks 32 and 33 covering their entire internal surfaces and thus enclosing their respective vapor spaces 36 and 38. Capillary arteries 34 and 37 are embedded in metal powder wicks 32 and 33 to serve as liquid flow paths from heat pipe condenser 14 in order to supply evaporator section 12 with liquid for evaporation. Capillary arteries can be either cable arteries 34, which are essentially a cable constructed of multiple continuous strands with capillary spaces between the strands, or as shown at capillary artery 37, a simple tube of appropriate capillary cross section.

In the preferred embodiment shown in FIG. 2, trailing edge chamber 30 is similar to leading edge chamber 26 and middle chamber 28 in that most of three of its internal surfaces are covered with metal powder wick 35. However, narrow cross section 42 of trailing edge chamber 30, the portion nearest to the trailing edge of evaporator section 12 of heat pipe 10, does not include metal powder. Instead, in order to provide a large pore path along which vapor generated at the very trailing edge of the chamber can be vented to the chamber's vapor space 40, screen wick 44 can be installed to fill narrow cross section 42. Screen wick 44 is in close capillary contact with metal powder wick 32 where they meet, but at least a part of screen wick 44 is open directly onto vapor space 40. Thus vapor generated within narrow cross section 42 has relatively unimpeded access to vapor space 40.

Another feature of trailing edge chamber 30 is that cable artery 46, which is embedded into metal powder wick 35 of trailing edge chamber 30 extends into middle chamber 28 and into metal powder wick 33 within middle chamber 28. This capillary connection formed by cable artery 46 helps assure that metal powder wick 35 and screen wick 44 will not be dried out by heat concentrated at the trailing edge of heat pipe evaporator section 12. It is particularly beneficial to have cable artery 46 extend not only into middle chamber 28, but to also use cable 46 as the capillary artery connection between middle chamber 28 and condenser 14. With such a structure not only does cable artery 46 furnish liquid to wicks 33 and 35, but because cable artery 46 interconnects the two wicks by following a short path through support rib 27, wick 33 also acts as a reserve liquid supply for wick 35.

To achieve similar liquid movement among all the evaporator chambers, it is sometimes advantageous to use metal powder wicks such as connection wick 47 to interconnect metal powder wicks 32 and 33. Metal powder wick connection 47 is formed around or within holes in support rib 25.

FIG. 3 is a cross section view of adiabatic section 16 of heat pipe 10 of the turbine nozzle of FIG. 1 at location 3—3. Adiabatic section 16 is actually simply an enclosed structure 49 with one or more vapor paths 50, which can be divided into any convenient configuration, and capillary arteries 34, 37, and 46, which are continuous from evaporator section 12 to condenser section 14. However, within adiabatic section 16, cable arteries 34 and 46 are fully encased within metal sheath 52 to separate the liquid within the cable arteries from the opposing flow of vapor.

FIG. 4 is a cross section view of condenser section 14 of heat pipe 10 of the turbine nozzle of FIG. 1 at location 4—4.

Condenser section 14 is a conventional heat pipe condenser with condensing metal screen wick 54 covering the internal surfaces of enclosed structure 56. Capillary arteries 34, 37, and 46, which extend all the way from evaporator 12, are also covered with continuous wick 54 within condenser section 14. As is common when tube capillary arteries are used, the portions of tube artery 37 which are embedded within evaporator wick 33 and condenser wick 54 can either be perforated or have splits within them to create easier liquid access between the wick and the interior of the capillary tube.

Thus, conventional heat pipe operation occurs when vapor which has moved from evaporator section 12 through adiabatic section vapor spaces 50 into condenser vapor spaces 58 condenses on wick 54, which is being cooled by input air B (FIG. 1). The condensed liquid then moves by capillary action through condenser wick 54, into capillary arteries 34, 37, and 46 and along the capillary arteries through adiabatic section 16 to evaporator section 12. In evaporator section 12 capillary forces continue to pump the liquid from the capillary arteries into evaporating wicks 32, 33, 35, and 44, within which the heat of the combustor output gases A (FIG. 1) cause the liquid to evaporate into vapor. The vapor then moves back to the condenser and the process is continuous.

The material of the preferred embodiment of the invention is essentially 316 stainless steel. This material is used in powder form for evaporator wicks 32, 33, and 35 and as screen for evaporator wick 44 and condenser wick 54, which is three wraps of 325 to 635 mesh stainless steel screen. Cable arteries 34 and 46 are also stainless steel and tube artery 37 and sheath 52 are stainless steel tubing. For the preferred embodiment 316 stainless steel is also used for the envelope for the condenser and the adiabatic sections while the evaporator envelope is constructed from Haynes 188 cobalt based super alloy.

By the use of the present invention and the materials of the preferred embodiment it is possible to operate a high pressure turbine stator at temperatures up to 1650 degrees centigrade and at pressures up to 250 pounds per square inch. Furthermore, the invention is expected to reduce fuel consumption by 1.6%, increase shaft horsepower by 1.8%, increase turbine efficiency by 1.8%, and increase the power-to-weight ratio by approximately 1.0%. Despite the seeming small numbers these improvements are considered significant results for high pressure turbines.

It is to be understood that the form of this invention as shown is merely a preferred embodiment. Various changes may be made in the function and arrangement of parts; equivalent means may be substituted for those illustrated and described; and certain features may be used independently from others without departing from the spirit and scope of the invention as defined in the following claims.

For example, materials other than stainless steel can be used for the various components to attain higher temperatures, more or fewer evaporator chambers and capillary arteries could be used, and, in some circumstances, screen wick 44 can be omitted and replaced with additional metal powder wick. Furthermore, cooling air can be supplied from sources other than turbine input air.

What is claimed as new and for which Letters patent of the United States are desired to be secured is:

1. A heat pipe for cooling a turbine engine stator comprising:

an evaporator section enclosed within a turbine stator vane which is exposed to hot gases, the evaporator